Accessory Dwelling Unit Team
CE290 Final Presentation

Accessory Dwelling Units:
Sustainable Housing for the Bay Area

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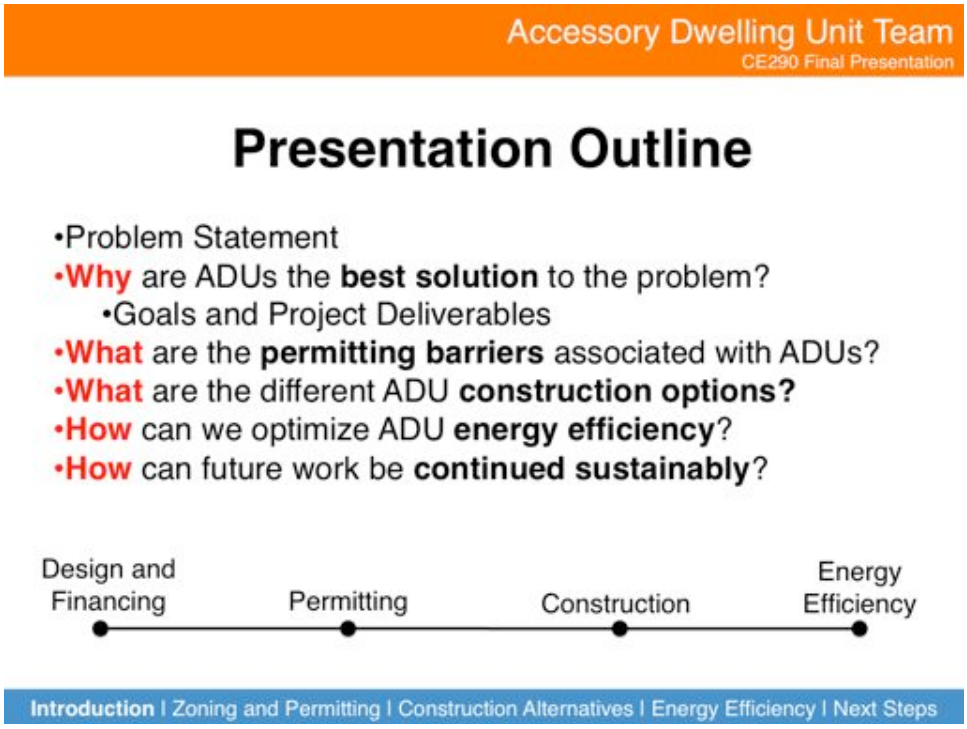
Introduction I Zoning and Permitting I Construction Alternatives I Energy Efficiency I Next Steps

WHAT IS AN ADU??!!

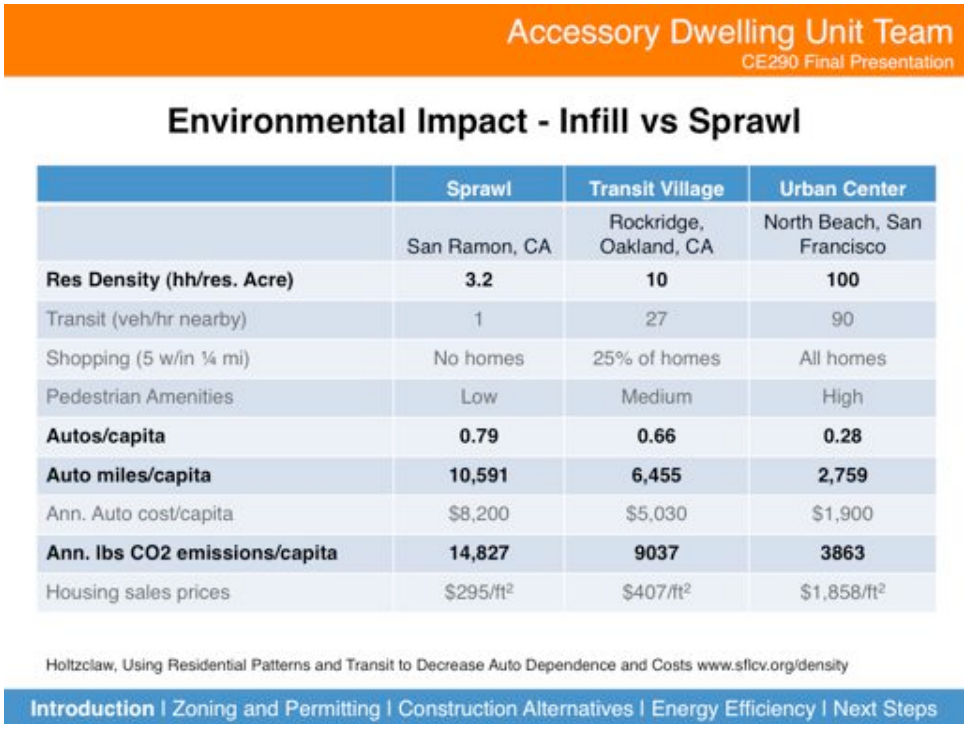


For most of our presentation, we're going to take you through the process as if you were a homeowner building an ADU. However, our mentors are mainly concerned with the design and financing side, so we're not going to talk about that as much.

Problem:

By the year 2035, the Bay Area's population is expected to grow by **2 million people**, requiring **700,000 new housing units**.

If current trends continue, most of this housing will be located in the suburbs, because that's where housing is most affordable.



We found data for different neighborhood types in the bay area. This chart shows the clear relationship between density and environmental impact through car usage. It also contains other information, showing that denser neighborhoods also have more transit options, shopping and pedestrian amenities, and other things associated with a more liveable neighborhood. But we wanted to focus here on the large impact that infill can have on reducing CO2 emissions.

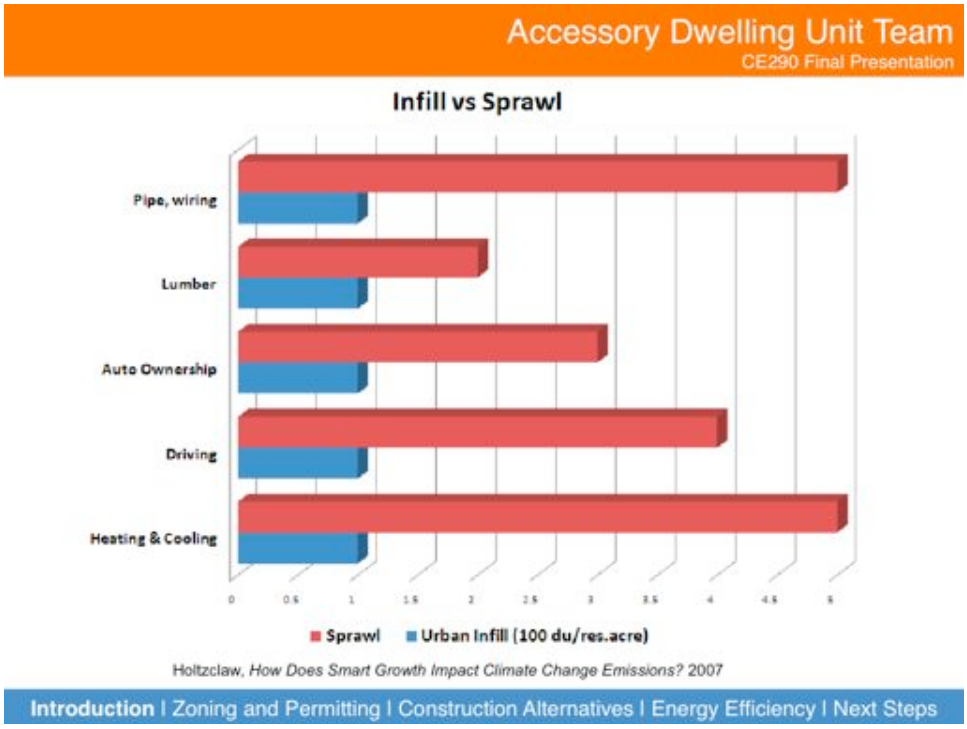
This is to say that when someone decides to move into the Bay the Area, the choice of where they live has significant environmental and social consequences, because with this choice comes an entire life-style. From this chart the impact of this life-style ranges by a factor of 4.

This chart also illustrates the type of neighborhood we are trying to target and why:

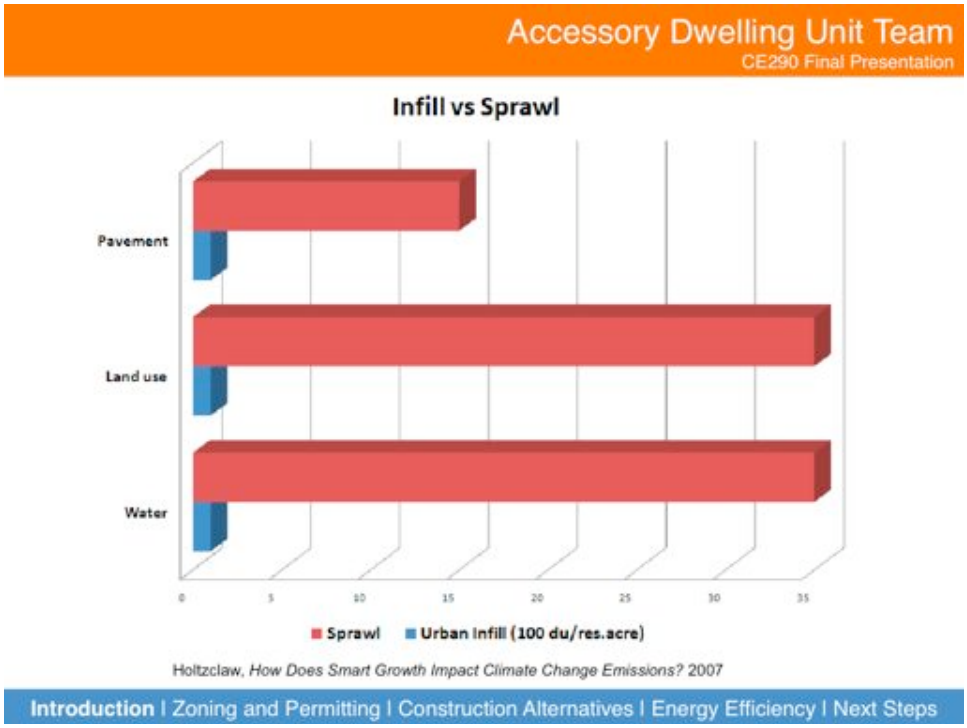
- The sprawling neighborhoods like San Ramon, don't have the critical mass or infrastructure to be conducive to additional housing.

- Urban centers are like San Francisco are already saturated

- So we will focus on these "transit villages", like Rockridge, West Berkeley. These are neighborhoods that have excisting infrastructure to handle additional people, but still have quite low density.



We also wanted to point out that in choosing infill rather than building out, reduced CO2 emissions from reduced driving is not the only benefit. The use of utility infrastructure, lumber and heating is also greatly reduced through infill.



The impact on pavement, land and water usage is even greater.

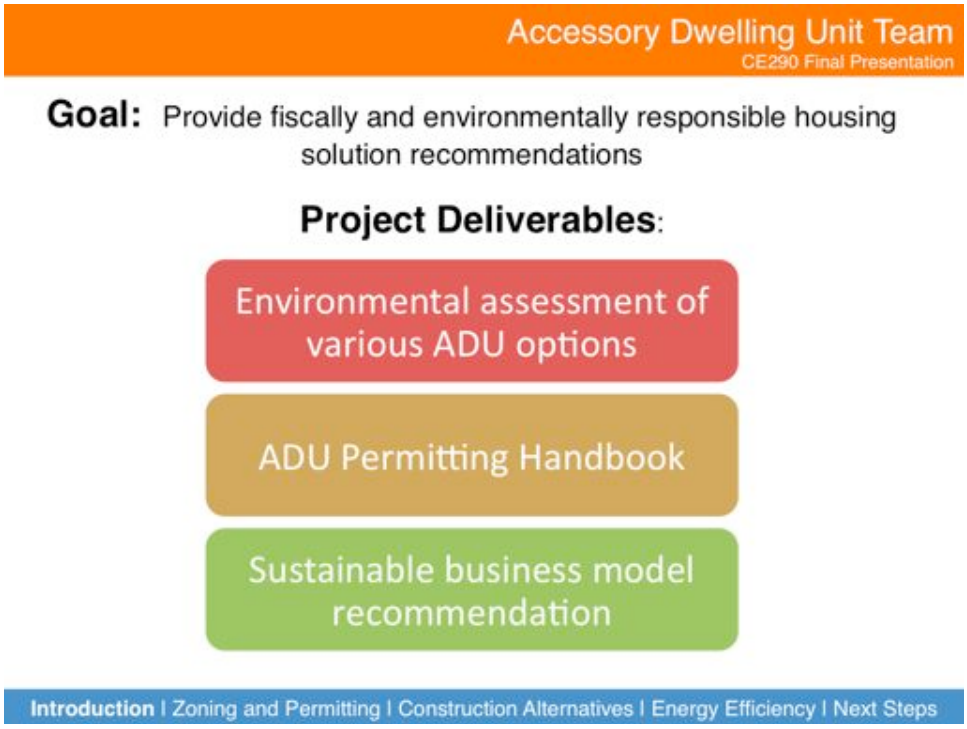
In these two graphs, everything has been benchmarked to urban infill i.e. for every meter of pavement used in infill housing, 15 is used for sprawl. For every liter of water used for infill, 35 is used for sprwl. It should be noted that these infill values are for high density infill (100du/res. Acre). We are working in the areas of around 20 units /res.acre, but the trends are the same.

Multiple Benefits…

Housing Benefits
- Meets needs of changing demographic trends i.e. smaller households, elderly, singles, empty nesters
- Affordable housing (smaller, increased supply)
- Additional income from rents

Environmental Benefits
- Decreases negative impacts of urban sprawl
- Increased density results in less auto-dependency
- Reduces demand to develop virgin land
- Energy efficient homes
- Uses existing infrastructure

Other Benefits:
- Strengthens existing neighborhoods
- Lower cost on cities, and increased tax revenues



The goal of this project

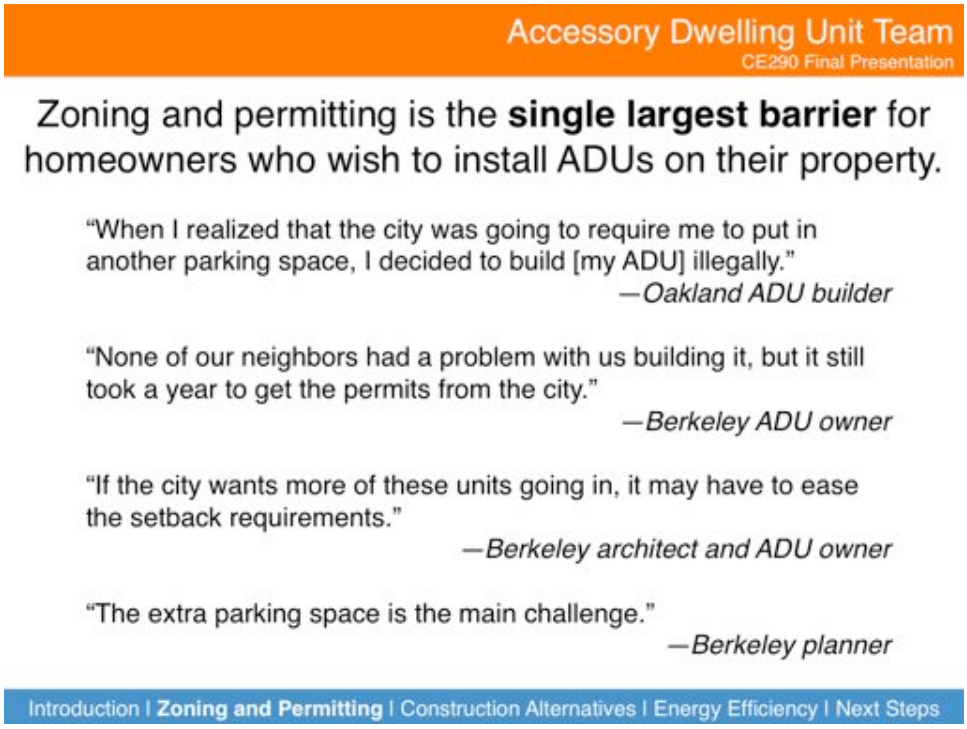
Short-term goals (1year): Build a couple homes as proof of concept, partnering with Cal-Cottages or Backyard Homes



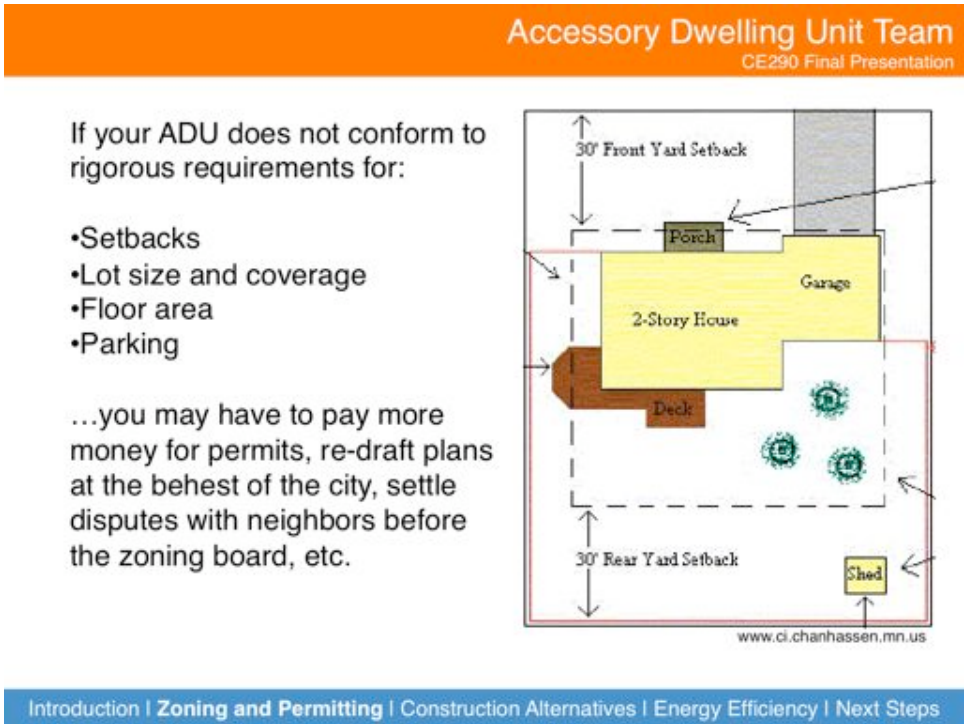

Cal-Cottages:

Foundations:
~ 2.5 weeks

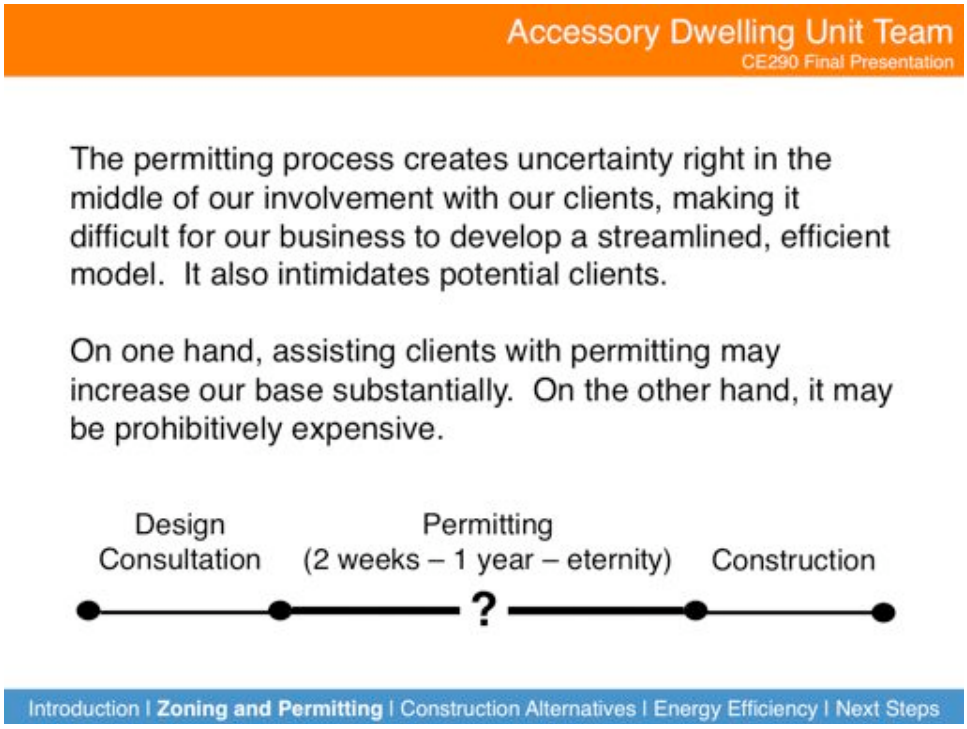
House:
Set House
~ 3 hours
Roofing + stucco, hardwood flooring
~ 4 days



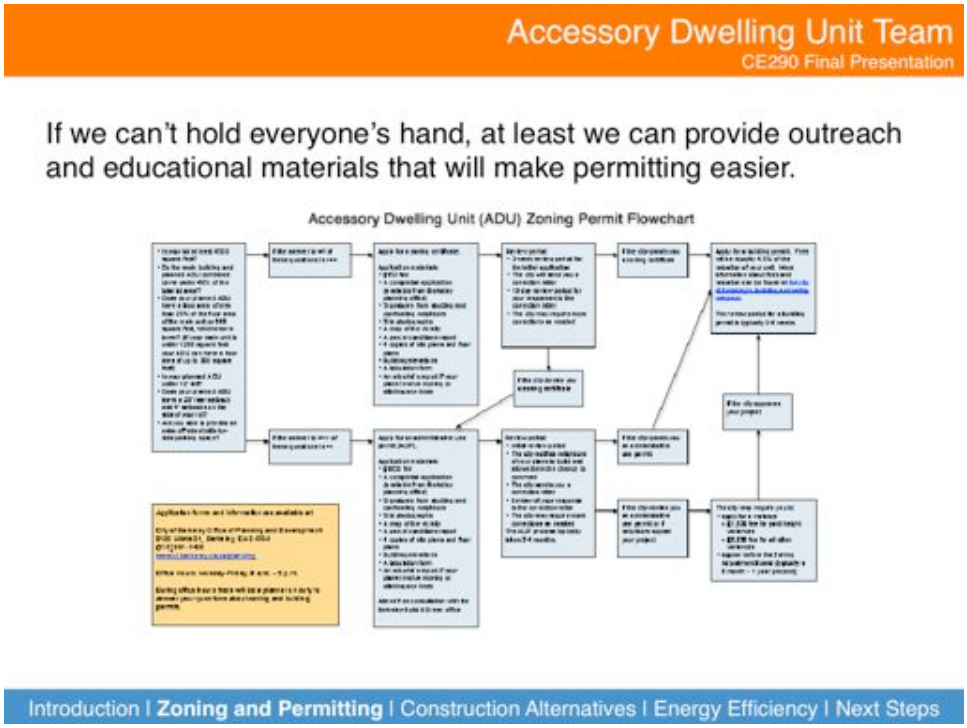
We interviewed 4 Berkeley planning staff, 2 developers, and 10 ADU dwellers/owners about the process of building an ADU. This was not comprehensive market research, nor did we feel that it needed to be, because all of our interviewees said the same thing.



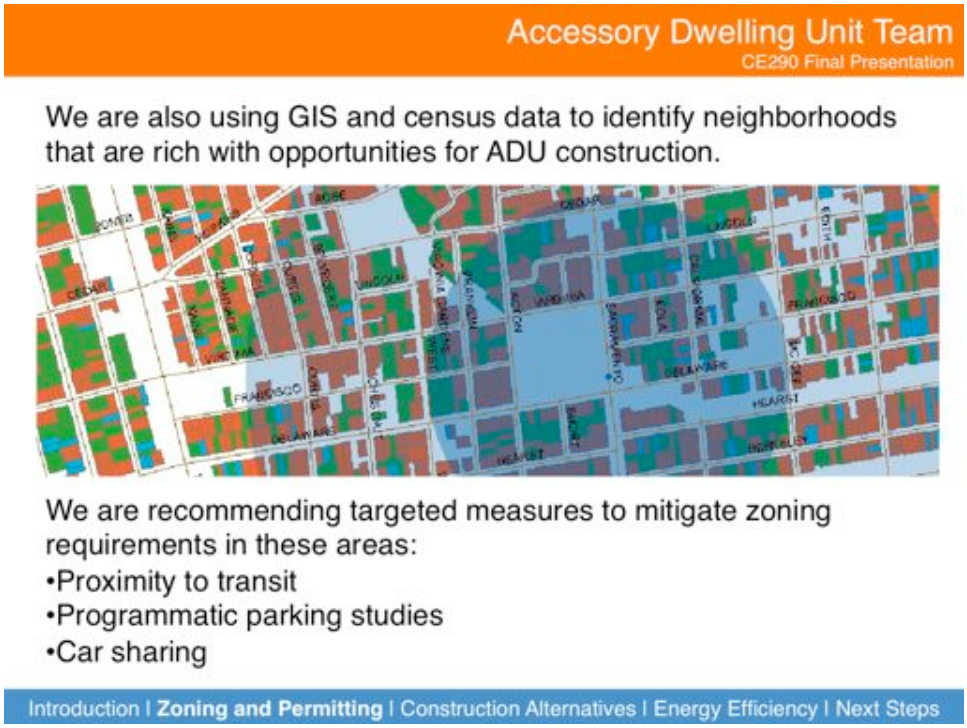
It's important to recognize that zoning laws are not the result of evil city officials or collusion between the City of Berkeley and big oil—they're over-protective and inflexible because they're the cumulative result of thousands of complaints by homeowners. *These very homeowners are our target market*. These requirements combine to make it difficult to build on small Berkeley lots, where there may not be much space for a legal ADU or a parking space. We researched four other Bay Area communities and found that lots are larger, but ADU requirements are often more strict.



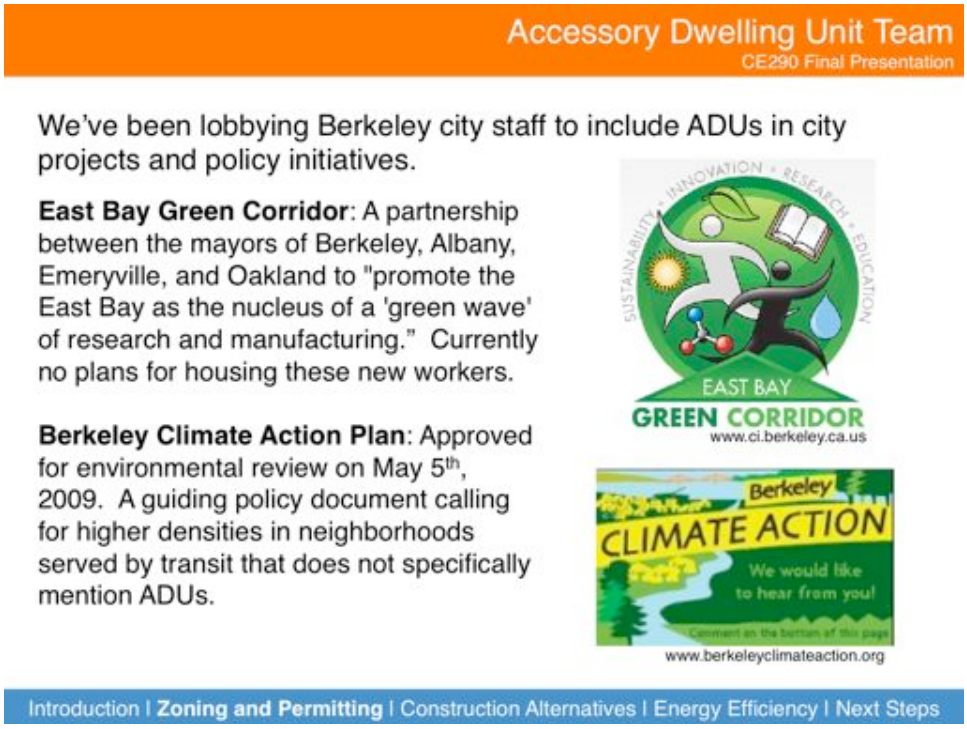
All of the homeowners that we interviewed who had successfully installed an ADU were architects or contractors.
The process also prevents challenges to scaling the business up, because each city has different zoning codes.
Developers can employ someone to spend 6 mos.-1 yr. defending a 500-unit development with a large profit margin, but the battle may be just as long with much less payoff for an ADU.



The flowchart shows just what a complex process this is. This should be easy information to get, but it's not. I had to compile it together from the city's zoning code and several different documents from the Berkeley planning office, as well as interviews with planners.



Lots with space for an ADU are in green, lots without space are orange, and lots that already have ADUs on them are blue. The blue-shaded circles represent quarter- and half-mile walks from the North Berkeley BART station.



Even if we were successful, it would take a year or two for us to actually change the zoning code, and the changes would only apply to one city, or even one neighborhood. But it would be a crucial long-term success.

Our criteria for assessing construction alternatives are:

- **Initial cost** (cost/ft^2)
- **Sizes available** (ft^2)
- **Ease of construction** (includes time on-site and off-site and lead time from initial customer order)
- **Level of customization**

Image sources:
http://citesix.com/newsfeed/wp-content/uploads/2008/12/livinghomes.jpg
http://www.palmharbor.com/resource/palmharbor/SiteObjects/published/
http://www.mkd-arc.com/homes/mklotus/images/tour/07.jpg

Alternatives Assessment

	Cost	Size (ft^2)	Cost/ft^2	Construction	Customization
Valley Home Designs					
Living Homes					
Michelle Kaufman	+	500	$250.00	+	-
Cal Cottages	+	700	$161.43	+	-
Backyard Cottages	++	627	$133.97	+	-
Zamore	-	400	$145.00	-	++
Flat Pack House					
Parco Homes					

- Costs are based on multiple models, and how inclusive costs are: transportation, design…
- Permitting costs not included

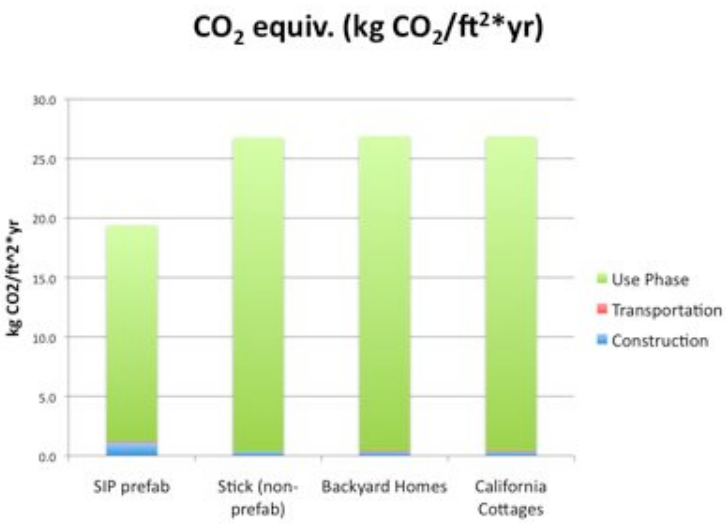
CO_2 equivalent (kg CO_2/ft²*yr)

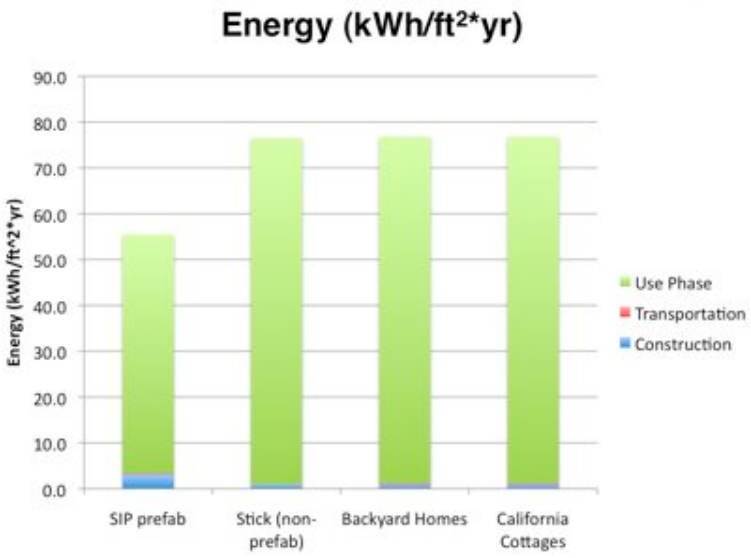
	SIP prefab	Stick (non-prefab)	Backyard Homes	California Cottages
Construction	1.1	0.3	0.3	0.3
Transportation	0.1	0.0	0.1	0.1
Use Phase	18.2	26.5	26.5	26.5
Total	**19.4**	**26.8**	**26.9**	**26.9**

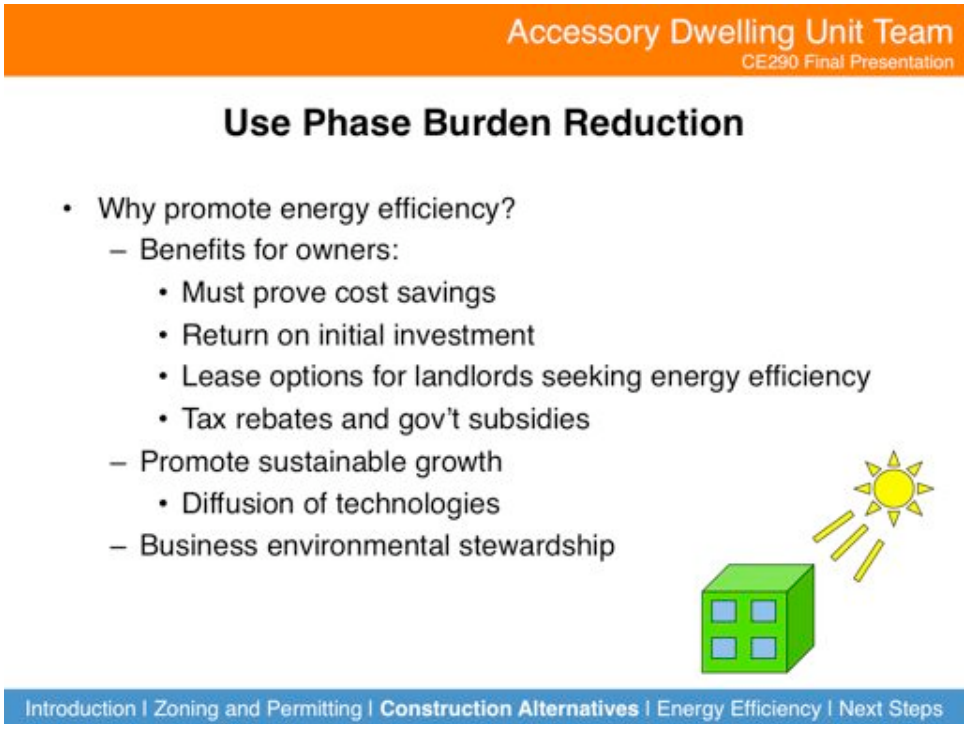
Energy use (kWh/ft²*yr)

	SIP prefab	Stick (non-prefab)	Backyard Homes	California Cottages
Construction	3.1	1.0	1.0	1.0
Transportation	0.3	0.0	0.3	0.3
Use Phase	52.0	75.6	75.6	75.6
Total	**55.4**	**76.5**	**76.8**	**76.8**

Source: CO^2 to kWh conversion factor: EIA 2007, http://www.eia.doe.gov/oiaf/1605/pdf/Appendix%20F_r071023.pdf
Bourne S, Liu S, Santiago A L, 2008.


CO_2 equiv. (kg CO_2/ft^2*yr)
kg CO2/ft^2* yr
30.0
25.0
20.0
15.0
10.0
5.0
0.0
SIP prefab
Stick (non-prefab)
Backyard Homes
California Cottages
Use Phase
Transportation
Construction


Energy (kWh/ft²*yr)
Energy (kWh/ft^2*yr)
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
SIP prefab
Stick (non-prefab)
Backyard Homes
California Cottages
Use Phase
Transportation
Construction



Promoting sustainable growth: allowing for the diffusion of technologies within the Berkeley community

Design for Efficiency

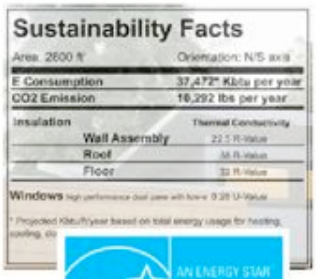
Appliance Options:

Refrigerator

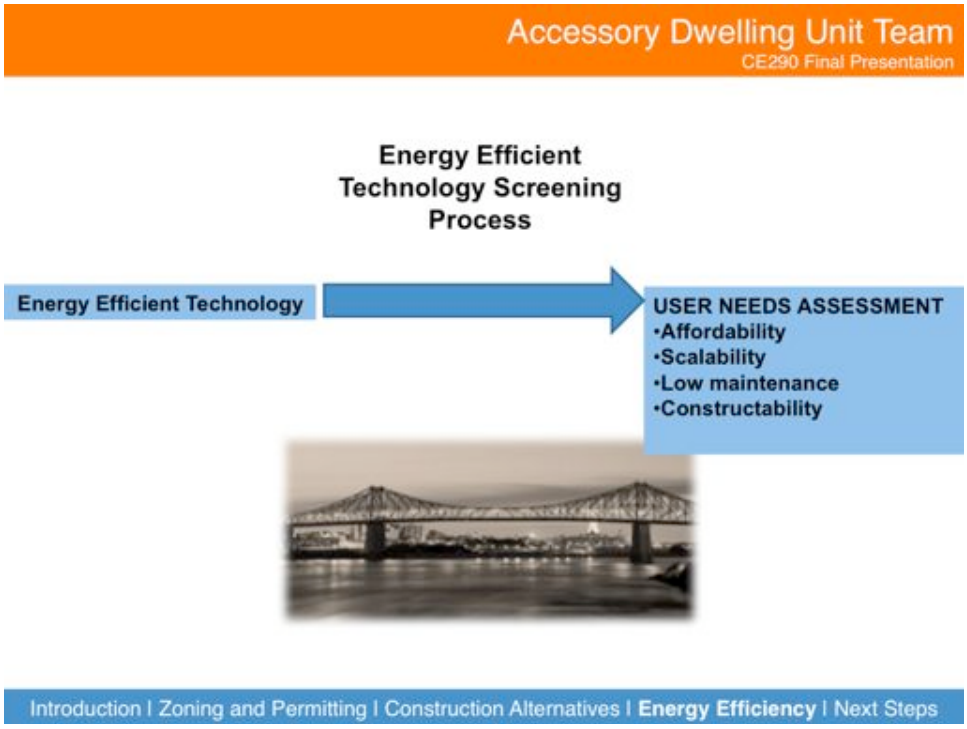
	Initial cost	Bill cost/month
EnergySTAR	$1,100	$43
Conventional	$1,070	$51
Savings	-$30	+$8

Dishwasher

	Initial cost	Bill cost/year
EnergySTAR	$545	$30
Conventional	$545	$54
difference	$0	+$24



Sources: Michelle Kaufmann's Blog. http://blog.michellekaufmann.com/?p=529
ENERGY STAR. "Features of ENERGY STAR New Qualified Homes." 2009. http://www.energystar.gov/index.cfm?c=new_homes.nh_feat
ENERY STAR. "Dishwasher Savings Calculator." 2009. http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/CalculatorConsumerDishwasher.xls.
ENERGY STAR. "Refrigerator Savings Calculator." 2009. http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/Consumer_Residential_Refrig_Sav_Calc.xls.



We may want to address Johanna's question about why energy efficiency is important here. - ER

Energy Efficient Technology Screening Process

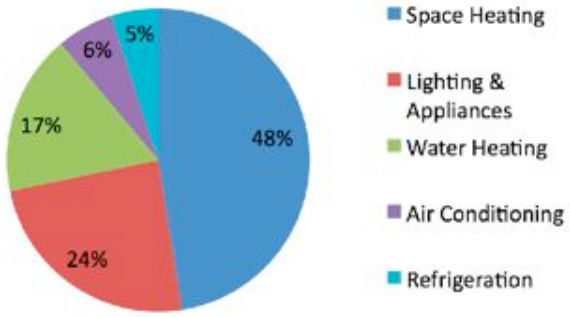
Idea Sourcing

Determine existing homebuilder's winning strategies	• Michelle Kauffman, Backyard Homes, Palm Harbor Homes, Brett Zamore
Consult Innovative Energy & Resource Technology Experts	• Iain Walker, Rick Diamond & Ashok Gadgil (LBNL) • Visit to the Pacific Energy Center (SF)
Implement Models to Evaluate Alternatives	• Energy Plus, Home Energy Saver (LBNL)

Image: BusinessWeek.com

Energy Efficient Technology Screening Process

Home Energy Use (Ave.)

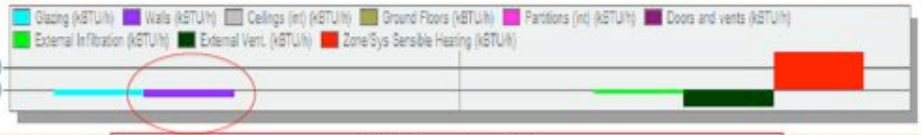


Data Source: http://www.eia.doe.gov/kids/energyfacts/uses/residence.html

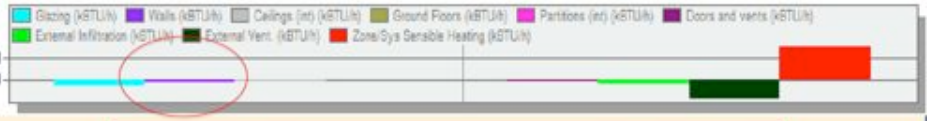
Energy Plus Model Output for Test Case

Sample Design Variable: Insulated Exterior Walls

Pictures/Data Source: DesignBuilder and Energy Plus Model



Uralita Thermalite, R-8.6
Heat Loss Through Exterior Walls = -2.75 kBTU/h

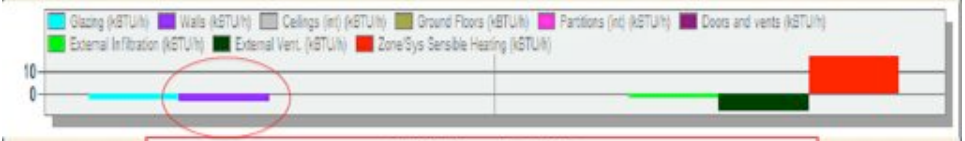


Expanded Polystyrene, R-30.4
Heat Loss Through Exterior Walls = -0.82 kBTU/h

Energy Plus Model Output for Test Case

Sample Design Variable: Insulated Exterior Walls

Pictures/Data Source: DesignBuilder and Energy Plus Model



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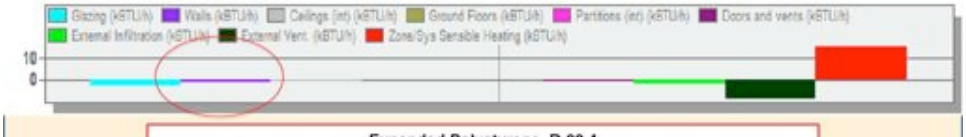


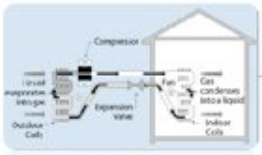
Expanded Polystyrene, R-30.4
Heat Loss Through Exterior Walls = -0.82 kBTU/h

Energy Efficient Technology Screening Process

Source: DesignBuilder

Building Envelope

http://
www.efficientwindows.org/
frames_.cfm?id=3



Heating & Cooling

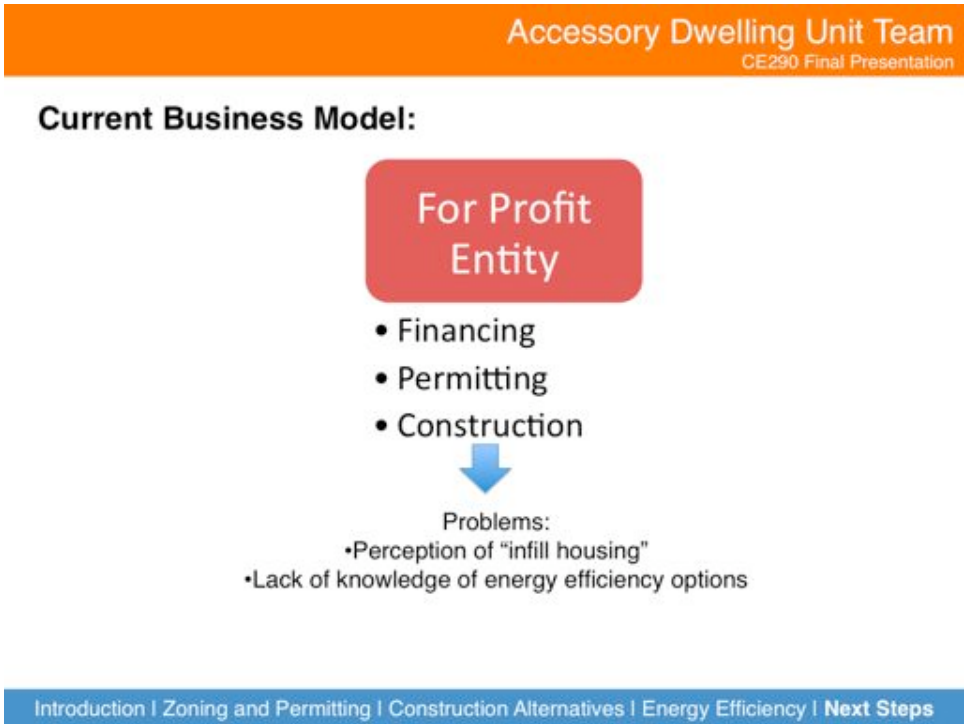
http://
www.efficientwindows.org/
frames

Efficient Appliances

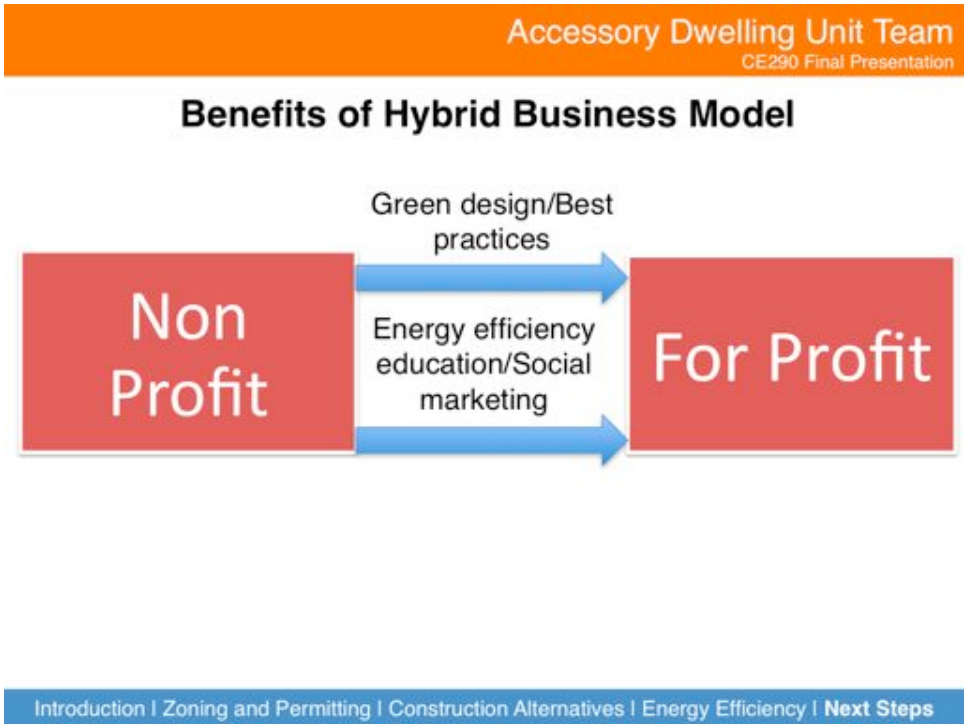
http://
www.efficientwindows.org/
frames_.cfm?id=3

Lighting & Orientation

www.lbl.gov



The current model that our mentors provided us with was a for profit entity that simply dealt with the financing permitting, and construction of the ADU. However, during our research we discovered a few problems with the model. First, there was an incredibly negative perception of infill housing and urban densification. When you mentioned those terms, people immediately conjured images of high rises and Manhattan style living- both of which Berkeley residents are averse to. Also, there seemed to be a lack of knowledge about energy efficiency options. Most people agreed that energy efficiency was important, but didn't think that it was affordable. However, As mentioned before, with the new tax refunds and initaitives through local, state and federal governments, it is making energy efficiancy a financially viable option. However, the public still doesn't seem to know.



Our recommendation is to create a hybrid non profit, for profit business model. Like UV Waterworks, the non profit part of the business would deal with education. In UV Waterworks, people needed to understand why the water was contaminated, why clean water was important, and how to get access to affordable clean water. Taking that to the energy space, the non profit wing will educate the public on why there is an energy shortage, why that's important, and how they can take steps to be more energy efficient in an affordable way. The other part the non profit will address is the gap between academia and market. The best green design practices at the University level will be transferred to the for profit entity for mass commercialization.

The philosphy of the non profit is the same as CE 290- cross sector collaboration breeds innovation. By leveraging the multiple colleges in UC Berkeley and streamlining work in the energy space, the goal is to create net zero ADUs which are both affordable and aesthetically pleasing; ready for mass commercialization and mass market consumption.

Next Steps:

- Summer 2009: Build ADU for Karen Chapple
- Summer 2009: Obtain venture funding for business
- Summer 2009: Coordinate energy education efforts with local Berkeley organizations

Short-term goals (1year): Build a couple homes as proof of concept, partnering with Cal-Cottages or Backyard Homes

Cal-Cottages:

Foundations:
~ 2.5 weeks

House:
Set House
~ 3 hours
Roofing + stucco, hardwood flooring
~ 4 days

Awards

Bears Breaking Boundaries

- Social Innovation: Honorable Mention
- Improving Student Life: Honorable Mention

Clinton Global Initiative

- Finalist

Berkeley Business Plan Competition

- Semi-Finalist

Thank you!

Professor Ashok Gadgil
Kevin Casey
Evan Schwimmer
Iain Walker
Rick Diamond
Karen Chapple
Leslie Mendez
Gisele Sorenson
Evan MacDonald
Jennifer Cogley

…and to our fellow CE290 students, especially those of you who presented last Wednesday. We stole a lot of your ideas.